A FARM LEVEL ANALYSIS OF THE RELATION BETWEEN CAP-REFORMS AND LOCAL ENVIRONMENTAL LEGISLATIONS: HOW AND IN WHICH EXTENT FLEMISH DAIRY FARMERS CAN FILL UP EXTRA MILK QUOTA?

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Abstract

The agricultural policies shift gradually from EU-level organised market interventions to local organised environmental policies. This paper explores the growth possibilities of the Flemish dairy sector with the outlook of a quota abolishment as a case study of this policy shift. The dairy quota policy seems very restrictive for the highly profitable Flemish dairy sector, but the environmental restrictions from the manure regulation can limit the growth of the dairy sector as well. The paper uses a spatial multi-agent simulation model applied to a sample of 40.000 farms to estimate price development of emission rights and their possible impact on the growth of the dairy production. The results show that a higher milk production leads to higher prices for emission rights. However, the increased cost of manure emission rights is not expected to impede dairy farm growth because the current milk quota rent estimates go far beyond the cost of manure emission rights.

KeyWords:milk quota, manure emission rights, mathematical programming, Flanders

JEL code:C02, C61, L11, Q18

Introduction

Flanders is a region in Belgium (The Northern part) with an intensive agricultural sector. In 2005 Flanders has 34,410 farms with a total agricultural production value of 4.471 billion €. The dairy sector is the third most important sub sector with a production value of 552 million € (11.7% of the total agricultural sector). In 2005, 8,128 dairy farms were active, holding 308,883 cows with a total dairy quota of 1.940 billion litres. The Flemish dairy sector is believed to be one of the most competitive dairy sectors in Europe (Breen et al., 2008; Cathagne et al., 2006; Dillon et al., 2008; Thorne and Fingleton, 2006), but the quota regulations currently prevent an expansion of the Flemish dairy production.

During the last year, signals from the European commission indicated that the milk quota is very likely to be abolished in 2015. The question is not if quota will be abolished but rather in which manner the quota this will happen. The most probable scenario is the so called soft-landing wherein milk quota are gradually enlarged from 2008 until 2015. Recently, the European council of agriculture has imposed a linear enlargement of the national quota in all member states with 2% from April 1st 2008.

From a purely economic point of view, one could expect that in high profitability regions, the extra available quota will be used completely and from 2015 on a shift in milk production from regions with a low profitability to regions with a high profitability will occur, meaning that the Flemish dairy sector would benefit and the milk production will increase. Despite the high profitability of the Flemish dairy sector compared to other regions, growth in milk production is not guaranteed, because the environmental legislation is becoming more restrictive and because the dairy sector must compete with other agricultural sub sectors within Flanders as well. Flanders is a region with a highly intensive animal production (e.g. pork and poultry) (DeSmet et al., 1996; Sleutel et al., 2007). The import of feed compounds have led to an excess of nutrients in the Flemish region resulted in a high pressure on the environment (Feinerman and Komen, 2005). The constantly deteriorating water quality and the introduction of Nitrate directive (91/676/EEC) at European level has resulted in a rigorous environmental policy framework at Flemish level: the manure decree (Van der Straeten et al., 2008). This decree regulates the manure disposition at farm level. Only a limited amount of manure can be spread on land according to the type of manure, the cultivated crop and the area. Basically, it works with a system of tradable emission rights where manure is labelled as the emission and where the right to spread manure on land is labelled as the emission right (Buysse et al., 2008).

Since the introduction of the manure decree, manure emission rights have been restricted further whereas the demand for emission rights still increases. Experts indicate that the price of the emission rights have gone up.

These increasing prices could hamper the expectations of a large increase of milk production in the Flemish region. The existence of this Flemish environmental legislation means extra costs for the farmer. Producing more milk leads to a larger nutrient excretion and thus extra manure disposal costs. The expansion of milk production will only take place if the gains of one extra litre milk are larger than the prices paid for the corresponding nutrient emission rights.

The tension between the drive to grow of a very competitive sector and the very restrictive environmental measures makes the Flemish dairy sector a good case to study the shift from price and market policies at European level to environmental policies more targeted at farm level. Therefore, the objective of this paper is to make an analysis at farm-level to asses the local impact of the EU quota enlargement in Flanders restricted by local policy measures, inspired by EU directives, and evaluate the repercussion at aggregated level.

The next section explains the main principles of the Flemish manure legislation.

The Flemish manure decree

In Flanders, the first regulatory norms with respect to manure were imposed in 1991 as a result of the introduction of the Nitrate Directive (91/676/EEC)[1]. This manure decree regulates the manure allocation but has changed through the years several times (Vervaet et al., 2004). Since 2003 MAPIIbis was imposed and the last major reform was in 2007 by implementing MAP III. The basic idea of both manure decrees is given in Figure 1.

[1] The main purpose of the directive was to protect the waters against pollution caused by nitrates from agricultural sources

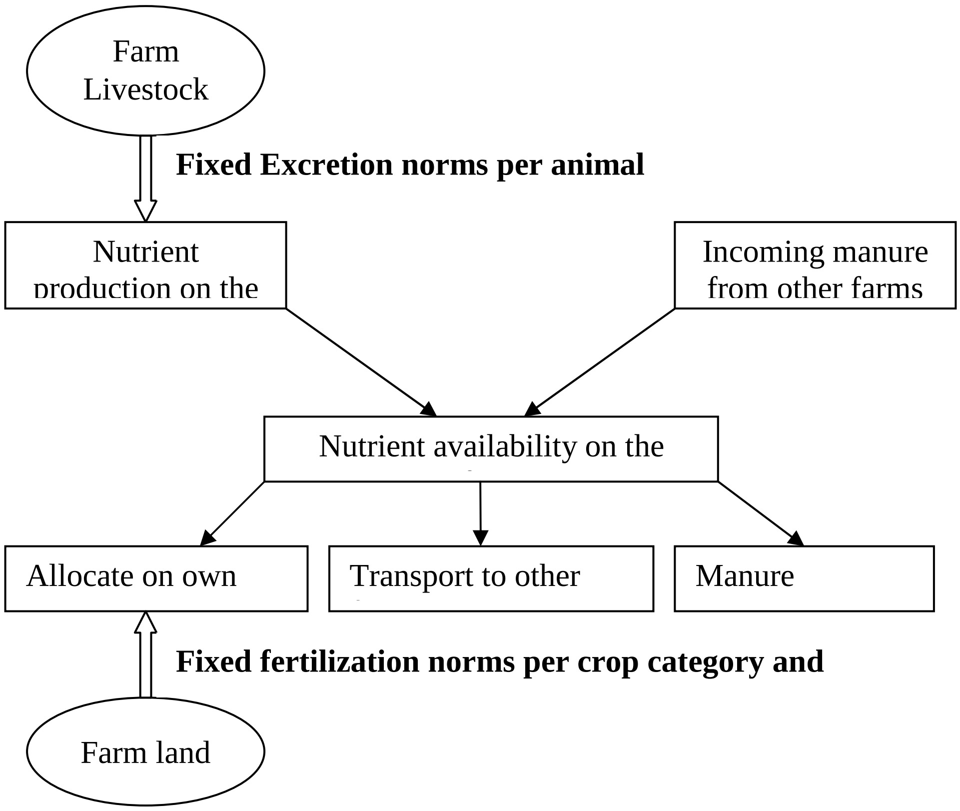

Figure 1: graphical representation of the structure of the manure decree

The most common way to calculate the nutrient production of the farm is using the animal number per type of animal multiplied by a related fixed excretion norm[2]. The total nutrient availability at the farm can be increased/decreased by importing/exporting nutrients from/to other farms. The sum of both sources is the quantity of nutrients the farmer has to dispose. In order to do this, the farmer has three possibilities. He can transport it to other farms, he can process the manure or he can dispose it on his own land. The latter option is currently often the cheapest solution and, therefore, the most used one. This possibility is limited by the four imposed emission rights according to the type of manure, crop category[3] and area[4]. The use of organic nitrogen (N) and inorganic nitrogen are each bounded by a maximum norm. More-over the joint use of both nitrogen types is also bounded by a third emission right. Finally the farmer must apply to the fourth emission right which bounds the joint use of organic and inorganic phosphorus (P_2O_5). In this paper we only consider the three emission rights with respect to Nitrogen. When the farmer can not dispose all his manure on his own land he can try to obtain sufficient emission rights from other farms (i.e. transport

[2] Departures from the fixed norms are possible but they involve high transaction costs for the farm
[3] The manure regulation subdivided crops into four different categories (grassland, corn, low nitrogen crops and other crops)
[4] In the manure regulations distinction is made between general area's and vulnerable area's (e.g. water, nature, phosphorus saturated area's)

manure to other farms). Finally processing the manure is the most costly one and in practice this option is only chosen when other possibilities are exhausted.

MAP IIbis was valid in the period 2003-2006 but was ineffective with respect to his main goal: improvement of water quality. Therefore, in 2007, a major policy change was implemented (MAP III). The structure of the manure decree remained unchanged but fertilization and excretion norms changed drastically because of new scientific evidence. The whole Flemish region became a vulnerable area, meaning that the maximum fertilization norm for manure is 170 kg nitrogen per hectare[5] (Table 1 and Table 2). The excretion norms for most of the animal species decreased. For dairy cows, however, nutrient emission was made proportional to the cow productivity (equation 1):

$$Y = 50 + 0{,}008 * X \qquad \textit{with} \qquad (1)$$

Y: N- excretion (Kg N/cow)

X: cow productivity (litre milk/cow)

In practice this means that the total nutrient excretion of dairy cows increased (under MAP II, the fixed norm was 97 kg nitrogen per year per cow).

This change in policy had some serious consequences for the Flemish agricultural sector. Most farms experienced a decline of their emission rights and became a surplus farm[6]. At aggregated level emission rights became more scarce and prices went up. Especially at dairy farms the consequences are high. Dairy farms cultivate mainly grassland and maize: crops for which the drop in fertilization norms was the strongest. At the same time dairy farms experienced an increase in nutrient production resulting in a large excess of manure on these farms.

Table 1: fixed general fertilization norms in kg/ha (*) (period 1/1/2003 until 31/12/2006) (MAP IIbis) (source: Vlaamse regering (2006))

Crop category	P_2O_5	Total N	Organic N	Inorganic N
Grassland	130	500	250	350
Maize	100	275	250	150
Low N crops (**)	100	125	125	100
Other crops (***)	110	275	200	200

*** Only the fertilization norms for the general areas are given. More stringent norms are imposed for vulnerable areas**

[5] European commission allows derogation for certain crops (e.g. grassland and corn) under certain conditions. With derogation fertilization norms can departure from the fixed norms. This allows to dispose more nutrients on the land (Claeys et al., 2008)
[6] Surplus farms produce more manure than they can dispose on their own land

****Crops with a low N demand, e.g. onions, chicory, clovers, fruit plantations, flowers,…**

*****All crops not belonging to one of the 3 other categories, e.g. potatoes, sugar beets, cereals, legumes, …**

Table 2: fixed general fertilization norms in kg/ha (period from 1/1/2007) (MAP III) (source: Vlaamse regering (2006))

Crop category	P_2O_5	Total N	Organic N (manure)	Organic N (other)	Inorganic N
Grassland	100	350	170	170	250
Maize	85	275	170	170	150
Low N crops (*)	80	125	125	125	70
Leguminose(**)	80	0	0	0	0
Sugar beets	80	220	170	170	150
Other crops (***)	85	275	170	170	175

***Crops with a low N demand, e.g. onions, chicory, fruit plantations, flowers,…**

****leguminose: all leguminose with exception of peas and beans**

*****All crops not belonging to one of the 3 other categories, e.g. potatoes, sugar beets, cereals, legumes, …**

Data

We used two data sources. The first database has been set up by the Flemish controlling administration: the Flemish land agency (FLA). It contains all variables related to production, transactions, acquisitions and use of nutrients for each Flemish farm individually. The database contains the complete population of 44,796 farms over a period of four years (2002-2005) with a total of 179,764 unbalanced panel observations. The second database is set up by the Flemish Department of Agriculture and Fishery (DAF). This administrative database includes a population of 21,059 farms with 379,062 unbalanced panel observations (from 1988 until 2005). The dataset contains the quota size for each farm in each year.

Because of complementary problems between DAF and FLA databases only 4,441 dairy farms could be linked between both databases, i.e. almost 55% of the Flemish dairy farms in 2005. These farms produces 1.2 billion litres of milk (58% of the total Flemish milk production).

Method

The basic manure allocation model

To capture the regional heterogeneity of manure production, a spatial mathematical programming Multi-Agent System model (MP-MAS) was developed. MAS offers the possibility of representing the individuals, their behaviour and their interactions. It enables us to construct artificial micro-worlds in which one can control all the parameters at all levels (Courdier et al., 2002). The present approach uses MP to simulate farmer decision-making and to integrate this decision-making with the legal part of the model. MP has been implemented in MAS by several researchers, for instance by Balmann (1997), Berger (2001), Becu et al. (2003) and Happe (2004). The use of MP at the core of the decision-making procedure is suitable to capture agent heterogeneity and economic trade-offs while focussing on constraints has a clear link to policy relevant questions (Schreinemachers and Berger, 2006). We assume an optimizing agent which minimizes his costs by allocating the manure in a normative way. The model consist of four major parts: legal descriptions, manure transport, manure abatement and cost-calculation. A more elaborated description of the model can be requested from the authors.

Costs for each allocation-option are assumed to be fixed expressed per volume (m^3) (Table 3). The simulation uses the four types of manure (bovine, pork, poultry and other) regarding nitrogen content per cubic metre (m^3) (table 4). The combination of both assumptions imply that costs per kg nitrogen are different between the four types of manure.

Table 3: assumed costs per allocation option

	Costs
Transport costs	0.12 €/m³/km
Disposal costs	12.5 €/m³
Processing costs	22.5 €/m³

Table 4: assumed nitrogen content for each manure type

	Nitrogen-content (kg N/m³)
Bovine	4.8
Pork	6.5
Poultry	29.8
Other	6

Because of the differences in costs between the three allocation options and the differences in nitrogen content between the four types of manure, the allocation strategy will follow a certain pattern. The distribution option (i.e. dispose the manure on the land) is the cheapest option. When all the available emission rights are used, the farmer will search for available emission rights at other farms. The final option is to process the manure. Manure from poultry has the highest nitrogen content, followed by pork, meaning that for these manure types, transport and processing costs per kg N are the lowest. The farmer will choose to dispose manure of bovine on his own land, followed by manure of other animals.

The regional manure pressure

The model takes the spatial and the regional aspects of manure production and manure disposition into account trough transport distances and costs. As the individual farms are optimising agents the model will search for the nearest located free emission rights. When a single surplus farm is situated nearby deficit farms, transport costs are low, however when a surplus farm is surrounded by other surplus farms, the transport distance to a deficit region will increase, resulting in an increasing transport cost per kg nitrogen.

The larger the distance to a region with non-used emission rights, the higher the transport costs will be. In a region were farms are confronted with such a high transport cost, an extra emission right on the farm itself will cause the largest decrease in total costs. This phenomenon is captured by the manure allocation equation of the model (equation 2):

$$\sum_m U_{mf} \leq R_{of} \quad [\lambda](2)$$

With U_{mf} the use of manure type m (kg N) at farm f and R_{of} the farm' emission right for organic nitrogen. The dual variable of the equation (λ) is a measure for the manure pressure (Buysse et al., 2008). The manure pressure is the willingness to pay of the farmer to dispose one unit of nitrogen at the land of another farm, meaning transport costs plus an extra fee to the farmer to dispose manure on his land. This regional aspect allows us to simulate the behaviour of the farmer regarding its own farm situation and regional situation towards the manure problem.

Linking milk production and manure pressure

To capture the interaction between milk production and regional manure pressure an extra module is build in where the nutrient production per farm can be measured based on its milk production. A higher (lower) milk production leads to higher (lower) nutrient production, resulting in a higher (lower) manure pressure on dairy farms. As nutrient excretion is made linear to cow productivity, a higher milk production causes a higher nitrogen production. The higher milk production can be achieved by holding more cows, by increasing the average cow productivity or by a combination of both.

The manure model works with the total farm population. As only 58% of the milk production is located in the model, it is necessary to adjust for the remaining 42%. The best possible solution is to adjust on municipality level. For each province (5 in Flanders) the true milk production is known. Then, for each province the milk production in the sample is calculated and subtracted from the true milk production. The remaining volumes are divided among the municipalities proportionally to the share of allocated milk production in the respective province. For each municipality an extra farm was introduced which is assumed to produce this extra allocated milk production. The introduction of this farms assures the representatives of production and allocation of manure to correctly predict changes in manure pressure.

Subject to the research question, two different approaches were used. With the first type of question one measures the effect on farm profitability of a quota enlargement of x% while the second type of questions measures the maximum possible quota enlargement given the sector profitability with respect to the environmental legislations. In the first approach a single iteration is performed where all farms will increase the milk production with x%. This approach is applied in section 5.1 and 5.2. In the second approach iterations are repeated n times. Two possible end-of-iteration criteria are built in: when the farm' regional manure pressure becomes larger than the quota rent (i.e. the profit of the last produced litre) or when the land used by the farmer becomes restrictive, i.e. we assume that dairy cows are 50% of the time outside and this means that the farm must have enough pasture to dispose at least 50% of the total nitrogen production of dairy cows and the young cattle on own land. As long as the farm has not reached one of the two criteria the quota will be enlarged. The optimization ends when all farms have reached the end-of-iteration criteria or when the maximum number of 20 iterations is exceeded. This approach is applied in section 5.3.

Reference cows

MAP II calculated nutrient excretion not made proportional to cow productivity, resulting in an equal nitrogen excretion for cows with different productivities and allocation costs per litre inversely proportional to the cow productivity. The MAP III policy calculates now nutrient excretion linear to the cow productivity, following equation 1. Based on this equation, highly productive cows excrete less nitrogen per produced litre of milk than low productive cows, but the advantage for farms with a high average productivity is lower then under MAP II.

Because of this productivity-dependent effect, a reference productivity has to be taken. We make simulations with two different assumption of reference cows. Cow–6250, with a productivity of 6,250 litre milk a year. In MAP III the corresponding nitrogen excretion amounts for 100 kg per year. Cow–9375 with a productivity of 9,375 litre milk per year and a corresponding nitrogen production of 125 kg.

Results

In the first part we analyse the sensitivity of the manure pressure indicator to the change in manure policy. In the second part we analyse if and in which extend the manure pressure, and thus the price of an emission right is influenced by a changing manure production. For that purpose, we use the case of an increasing dairy production. In the third part we calculated the possible growth in milk production in Flanders.

Sensitivity of manure pressure to changing manure policy

Table 5 gives the most important simulation results for MAP II and MAP III.

Table 5: simulation results of a shift from MAP II to MAP III

	Map II	Map III
Milk production (l) (*)	1,200,467,796	1,200,467,796
Nutrient excretion of dairy cows (kg N) (*)	14,597,067	15,687,721
Average manure pressure (dairy farms) (€/kg N)	0.6887	1.3009
lowest manure pressure (dairy farms) (€/kg N)	0.0000	0.0489
highest manure pressure (dairy farms) (€/kg N)	2.0833	2.0833
Average manure pressure (non- dairy farms) (€/kg N)	0.6092	1.0449
Lowest manure pressure (non- dairy farms) (€/kg N)	0.0000	0.0356
Highest manure pressure (non- dairy farms) (€/kg N)	2.0833	2.0833
Average manure pressure (all farms) (€/kg N)	0.6297	1.1035

(*) only dairy farms included in the sample

The current milk production of the sample accounts for 1.2 billion litres of milk. Under MAP II, the cows excrete 14.6 million kg of nitrogen. Under MAP III this has increased with 1 million kg to 15.6 million kg. The introduction of MAP III has some serious consequences for all farms and in particular for dairy farms. The average price for emission rights increased in Flanders with 75%. Dairy farms are confronted with an increase in price of almost 90%. This strong increase in prices is caused by growth in demand for and the simultaneously decrease in the supply of emission rights.

The average manure pressure on dairy farms under MAP III-policy is 1.3009 €/kg N. This means that in a perfect market the farmer would pay up to 1.3009 € to dispose 1 kg of nitrogen (transport costs included). Other farms (i.e. non-dairy farms) experience a lower average manure pressure (1.0449 €/kg N). The reason for this lower manure pressure is the lower share of manure of type ‘bovine’ in these farms. Because of the low nitrogen content of this manure type, the allocation costs per unit of nitrogen are larger.

To see what the shift in policy means for the farm profitability, one has to express the allocation costs per litre of produced milk.

Changing from map II to map III increased the manure pressure on dairy farms from 0.6887 to 1.3009, meaning the costs for manure allocation for cow-6250, increased from 66.80 € to 130.09 €. Expressed per litre of milk produced, the average allocation costs increased from 1.07 eurocent per litre milk to 2.08 eurocent per litre (+94.4%).

Cathange et al. (2006) have determined the average unit quota rent on the short, middle and long run for Belgian dairy farms. The long run quota rent, which is the lowest of the three and takes also land into account as a cost, is 9.1 eurocent per litre of milk. Despite the almost doubled prices for emission rights, the increase in average price is still much lower than the gain of the last produced litre of milk.

Sensitivity of manure pressure to changing milk productions

The results of the simulation are given in table 6.

Table 6: simulation results of an increasing milk production, assuming a constant cow-productivity

	Current production (2005)	+1%	+2%	+5%	+10%	+20%
Milk production (*) (1000 l)	1,200,468	1,212,472	1,224,477	1,260,491	1,320,515	1,440,561
Nutrient excretion of dairy cows (1000 kg N) (*)	15,688	15,794	16,014	16,482	17,275	18,823
Average manure pressure (dairy farms)	1.3009	1.3033	1.3136	1.3285	1.3439	1.3878
lowest manure pressure (dairy farms)	0.0489	0.0528	0.0537	0.0572	0.0662	0.0766
highest manure pressure (dairy farms)	2.0833	2.0833	2.0833	2.0833	2.0833	2.0833
Average manure pressure (non-dairy farms)	1.0449	1.0468	1.0547	1.0661	1.0785	1.1126
Lowest manure pressure (non-dairy farms)	0.0356	0.04	0.0404	0.0439	0.0553	0.0702

Highest manure pressure (non-dairy farms)	2.0833	2.0833	2.0833	2.0833	2.0833	2.0833
Average manure pressure (all farms)	1.1035	1.1055	1.1139	1.1261	1.1391	1.1755

(*) only dairy farms included in the sample

Table 6 shows the effect of an increasing milk production on the experienced manure pressure. Because of the corresponding higher nitrogen production, farms face a higher manure pressure. However, the effect on the manure pressure is rather low, i.e. with a production growth of 5% compared to the current production, the average manure pressure on dairy farms will only increase to 1.3285 (+2.12%). A milk production growth of 20% will only cause an increase of manure pressure on dairy farms with 6.68% to 1.3878 € /kg N. The relation between production growth and average manure pressure on dairy farms is given in equation 3.

$Y = 1.3 + 0.0047 * X$ *(R^2= 0.9962) with(3)*

Y: average manure pressure on dairy farms (€ /kg N)

X: dairy production growth (percentage of growth against current production)

Equation 3 shows the positive relationship between growth in milk production and the average manure pressure on dairy farms. For each percentage of extra milk production, the average price of emission rights will increase with 0.47 eurocent.

Because of the linear relation between milk production and nitrogen production, allocation costs per unit of milk can vary depending on cow-productivity. For high productive cows, the nitrogen excretion expressed per litre milk is lower than for low productive cows.

For the reference cow-6250 the allocation costs per litre of milk produced, amounts for 0.0208€. Assuming a production growth of 5%, the allocation costs per litre milk will rise to 0.0213€ (+2.40%). This is only an increase of 0.5 eurocent per litre of milk. The allocation costs for cow-9375 come to 162.6 € and expressed per litre milk this is 0.0173 €. Again, assuming a production growth of 5%, the allocation costs per litre of milk will rise up to 0.0177 € (+2.3%). This is only an increase of 0.4 eurocent per litre of milk. Thus, the manure allocation costs per litre milk will be lower for high productive cows.

The comparison of the estimated profitability from literature and the current manure allocation costs suggests that emission rights prices will not stop the growth in milk production. The next section analyses the possible expansion based on an iterated simulation model.

Possible growth in the Flemish agricultural sector

The previous topics have shown that allocation costs are rather small compared to the margins of milk production and thus will have a small influence on the total Flemish dairy production level. To see the effect of the increase in prices of emission rights on milk production, the iteration procedure is performed where for each step a production growth of 2% is used. The main objective of this iterated simulation model is to check how many farms can increase their quota in spite of the increased manure disposal cost. Therefore, the increase of quota in the simulation model quota on a farm stops when the farm' regional manure pressure becomes larger than the quota rent. We assume a fixed quota rent and without taking the manure disposal costs into account. Next to the manure pressure, the model takes also the limitation of available land into account by stopping the increase of quota when there is not enough farmland available for grazing. The maximum number of iterations is 20, meaning the farm in the model can grow 40% at most.

The output of the simulations in table 7 show the results of 4 different assumptions on quota rent compared with the current production level. The highest assumed quota rent is based on Cathange et al. (2006) and because of the discussion on quota rent estimate we have chosen 3 lower quota rent levels too.

Table 7: simulation results of a changing quota rent for milk quota

	Current production (MAP III)	Assumed milk quota rents (euro/litre)			
		0.0125	0.015	0.025	0.091
Milk production (1000 l) (*)	1,200,468	1,261,703	1,285,426	1,527,731	1,649,759
Nutrient excretion of dairy cows (1000 kg N) (*)	15,688	16,535	16,817	19,869	21,579
Average manure pressure (dairy farms)	1.3009	1.3325	1.3401	1.4290	1.4826
Lowest manure pressure (dairy farms)	0.0489	0.0932	0.0932	0.1289	0.1419
Highest manure pressure (dairy farms)	2.0833	2.0833	2.0833	2.0833	2.0833
Average manure pressure (other farms)	1.0449	1.0718	1.078	1.1557	1.2005
Lowest manure pressure (other farms)	0.0356	0.0553	0.0561	0.1024	0.1052

Highest manure pressure (other farms)	2.0833	2.0833	2.0833	2.0833	2.0833
Average manure pressure (all farms)	1.1035	1.1314	1.1379	1.2182	1.2650
Number of farms with end-of-iteration ‘land’	/	112	117	227	336
Number of farms with end-of-iteration ‘manure pressure’	/	4,129	3,932	1,806	0
Number of farms with end-of-iteration	/	4,140	3,946	1,953	336
Number of farms without end-of-iteration	/	301	495	2,488	4,105

Table 7 shows that the assumption on quota rents determine the results to a very large extent. A very high quota rent implies that a production increase pays off the increase of manure disposal cost. As a result, the limitation of available land is more binding than the manure disposal cost.

With the estimated quota rent of 0.091 Euro per litre (Cathagne et al., 2006), non of the farms will stop to grow because of the manure pressure criteria. This means that, when this quota rent holds, farms would not be affected by the raising manure pressure and growth would be unlimited. Only the existence of other constraints or increasing cost as a consequence of increasing scale could prevent farms from growing.

With a smaller margin, e.g. 0.0125€ / litre milk, after 20 iterations, only 6.8% of the farms is still able to grow. At this point the total milk production is increased with 5.1%. The margin of 0.0125€ / litre milk is however not very realistic because the cost of manure disposal is currently already higher on 68.5% of the farms. With a margin of 0.025€/litre milk, 56% of the farms could be able to cover the cost of manure disposal and has sufficient land to grow more than 40%. The sum of all increases topped at 40% results in a net increase of the total milk production of 27.3%. However, also the assumed margin of 0.025€/litre milk seems to be rather low because currently already 31.5% of the farms has a higher manure disposal cost than the assumed margin.

Conclusions

This paper analyses the role of manure emission rights on the impact of quota enlargement or abolition. Milk quota fix the dairy production at farm level and at member-state level while manure-allocation rights limit the use of nitrogen on cultivated land. Until now, the milk quota were the most binding constraint for milk production. But the soft-landing of the milk quota regime or the complete abolition of milk quota raises the question at which production and profit level on the manure emission rights become binding for the Flemish dairy production.

A production growth of 20% (!) results in an extra nitrogen production of 4.1% at Flemish level and a corresponding increase in emission right prices of 6.68% at dairy farms. Assuming a cow productivity of 6,250 litre milk a year, the 6.68% represents an average increase of 0.14 eurocent per litre of milk resulting in a total average cost of emission rights of 2.2 eurocent per litre. Comparing this emission right cost of 2.2 eurocent per litre to quota rent estimates for Belgium of 9.1 leads to the conclusion that the Flemish environmental policy represents a measurable cost of production but is not as binding and expensive as the dairy quota.

Because of the rather small increase in allocation costs, one may expect that the manure regulation will not be the major determinant of the Flemish milk production. This result is confirmed by an iterative model that uses an initial assumed quota rent to simulate successive quota expansion. With only taking the dairy quota legislation, manure legislation and land constraints into account and with the assumption of the gross margin of 2.5 eurocent per litre of milk, 56% of the farms would be able to expand the production with more than 40%. With an assumed margin of 9.1 eurocent per litre of milk, farm growth is only stopped because of the lack at pasture land on the farm.

An increasing milk production would lead to increasing prices for emission rights. However, under perfect market conditions, the supplementary price is much lower than the profits achieved by producing extra milk. Thus in a purely economic point of view, the extra quantity of produced nutrients can not limit the quantity of produced milk, *ceteris paribus.*

However three remarks have to be made. First, this is only a one-side approach of the total problem. The manure legislation regulates, besides the manure allocation, also the manure production. Animal production rights limits the total number of animals per farm. When a farm wants to expand his livestock, extra rights are necessary. Therefore the farmer has to purchase these rights from other (stopping) farms or he can, under certain conditions, apply for new rights to the government. These conditions are rather strict and deal mainly with complying with the manure processing rules at farm and at Flemish level. The restricted quantity of animal production rights and the strict rules to emit new rights can restrain the growth in milk production. Because the lack of data, this aspect is not analysed yet.

Another remark is that in our approach margins per litre of milk are assumed to be uniform and constant over all farms. To know the exact margins for each farm and how they would be affected by increasing production, individual FADN data should be used. However FADN data could not be linked with DAF or FLA data.

The third remark is that use is made of the well-known perfect market assumption. In reality the market does not works perfect. Many deficit farmers choose not to accept manure from other farms in spite of the offered payments (Van der Straeten et al., 2008). Other farmers wish to accept the manure but do not find a surplus farm because of the non-transparency of the market. This non-optimal functioning of the market can lift the prices for emission rights up.

References

Balmann, A. 1997. Farm-based modelling of regional structural change: A cellular automata approach. European Review of Agricultural Economics 24:85-108.

Becu, N., P. Perez, A. Walker, O. Barreteau, and C. Le Page. 2003. Agent based simulation of a small catchment water management in northern Thailand description of the CATCHSCAPE model. Ecological Modelling 170:319-331.

Berger, T. 2001. Agent-based spatial models applied to agriculture: a simulation tool for technology diffusion, resource use changes and policy analysis. Agricultural Economics 25:245-260.

Breen, J., T. Donnellan, T. Hennessy, and F. Thorne. 2008. A farm level analysis of the impact of milk quota reform: integrating econometric estimation with optimisation models 107th EAAE Seminar "modelling of agricultural and rural development policies", Sevilla, Spain.

Buysse, J., B. Van der Straeten, D. Claeys, L. Lauwers, F.L. Marchand, and G. Van Huylenbroeck. 2008. Flexible quota constraints in positive mathematical programming models 107th EAAE Seminar "Modelling of Agricultural and Rural Development Policies", Sevilla.

Cathagne, A., H. Guyomard, and F. Levert. 2006. Milk quotas in the European Union: Distribution of Marginal Costs and Quota Rents 01/2006. EDIM.

Claeys, D., L. Lauwers, F.L. Marchand, J. Van Meensel, J. Buysse, B. Van der Straeten, and G. Van Huylenbroeck. 2008. Derogation on the EU nitrates directive; does it make the difference? XIIth congress of the European Association of agricultural economists, Ghent, Belgium.

Courdier, R., F. Guerrin, F.H. Andriamasinoro, and J.M. Paillat. 2002. Agent-based simulation of complex systems: application to collective management of animal wastes. Jasss-the Journal of Artificial Societies and Social Simulation 5.

DeSmet, J., G. Hofman, J. Vanderdeelen, M. VanMeirvenne, and L. Baert. 1996. Phosphate enrichment in the sandy loam soils of West-Flanders, Belgium. Fertilizer Research 43:209-215.

Dillon, P., T. Hennessy, L. Shalloo, F. Thorne, and B. Horan. 2008. Future outlook for the Irish dairy industry: a study of international competitiveness, influence of international trade reform and requirement for change. International Journal of Dairy Technology 61:16-29.

Feinerman, E., and M.H.C. Komen. 2005. The use of organic vs. chemical fertilizer with a mineral losses tax: The case of Dutch arable farmers. Environmental & resource economics 32:367-388.

Happe, K. 2004. Agricultural polices and farm structures: agent-based modelling and application to EU-policy reform. IAMO.

Schreinemachers, P., and T. Berger. 2006. Land use decisions in developing countries and their representation in multi-agent systems. Journal of land use science 1:29-44.

Sleutel, S., S. De Neve, and G. Hofman. 2007. Assessing causes of recent organic carbon losses from cropland soils by means of regional-scaled input balances for the case of Flanders (Belgium). Nutrient Cycling in Agroecosystems 78:265-278.

Thorne, F., and B. Fingleton. 2006. Examining the relative competitiveness of milk production: an Irish case study (1996-2004). Journal of international farm mangement 3.

Van der Straeten, B., J. Buysse, F.L. Marchand, L. Lauwers, D. Claeys, and G. Van Huylenbroeck. 2008. Fertilization: trade-offs between manure abatement and plant productivity XIIth congres of the European Association of agricultural economists, Ghent, Belgium.

Vervaet, m., L. Lauwers, S. Lenders, and s. Overloop. 2004. Het Driesporen-mestbeleid: evaluatie en toekomstverkenning. Centrum voor Landbouweconomie, Brussel.

Vlaamse regering. 2006. Decreet houdende de bescherming van water tegen de verontreiniging door nitraten uit agrarische bronnen.